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ABSTRACT

The purpose of this guide is to present the essential technical considerations for implementing the North Carolina Instructional Technology Plan (NCITP). It addresses three main areas fundamental to the development and execution of long-range technology plans: collaboration, connectivity, and hardware/software configurations. The first section recommends that collaborative undertakings be considered for the following areas: purchasing, evaluation, support, maintenance, training, license management. The second section outlines the following issues that impact connectivity decisions: security, support, resource availability, wiring, electronics, LAN, WAN. The third section is divided into four subsections on determining requirements, model hardware/software and network configurations, comparison of model configurations, and other considerations. A final section provides a table that references all of the documents available to support the technological infrastructure needed for the instructional initiatives. (AEF)

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North Carolina Instructional Technology Plan

Guide:

Technological Recommendations and Standards

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INTRODUCTION

The primary purpose of this guide is to present the essential technical considerations for implementing the North Carolina Instructional Technology Plan (NCITP). It addresses the following three main areas fundamental to the development and execution of long-range technology plans:

- collaboration
- connectivity
- hardware configurations

These technical standards provide a foundation for the collaborative planning and support efforts among local, regional, and state-level groups. Support areas are of particular importance to the usefulness of the NCITP, the worthiness of the individual school technology plans, and the ultimate success of the technical infrastructure at the local school buildings. Areas of primary interest include personnel training (i.e., numbers, types, and organization of staff), purchasing (e.g., potential use of statewide, high-volume discounts and minimization of administrative efforts), and management (e.g., use of common staffing resources and facilities for managing software, providing technical assistance, and performing research and development tasks).

The proper implementation and employment of current available technology (including hardware, software, and communications) has been a consideration in creating the recommendations and standards. More emphasis, however, has been placed on the ability to:

- accomplish an orderly and cost-effective scalability and growth of technical resources (e.g., the transition from standalone workstations to local-area networks—LANs, from networked labs to schoolwide networks, from school networks to a wide-area network—WAN)
- achieve economically practical widespread and effective communications with the outside world
- address the connectivity issues of security, instructional resource availability, and adequate human resources

The technical standards have been developed through a logical and iterative process, beginning with the instructional requirements for achieving outcomes identified in the state's Standard Course of Study. Representative applications software packages that target important categories of educational technologies were identified, and alternative hardware and network configurations were formulated based on software requirements and emerging trends.

The technical recommendations and standards consist of (a) statewide specifications for items common to all installations; (b) model hardware/software and network configurations; and, (c) other considerations, such as retrofitting present equipment and addressing building, wiring, and cabling issues. The standards and recommendations outlined in this guide will serve as examples, aids, and references for assisting local schools in developing plans and building technical facilities.

Traditional uses of instructional computers have addressed the areas of drill and practice, supplemental instruction, and computer programming. The implementation of the architecture described in this document will contribute materially to providing capabilities beyond these basic functions. Students and teachers will be able to explore, discover, research and communicate with worldwide resources in order to fulfill both structured educational requirements and to pursue the personal enrichment of each individual. It is intended that access to necessary resources will be available, regardless of time of day or geographic location.

Through the wise and judicious use of support resources, the NCITP offers a unique and far-reaching opportunity for the state to address comprehensively the planning for and implementation of technology for instructional purposes in its public schools. The form and focus of the supporting resources must link directly to the methods and practices of implementing the technical standards. Without adequate, well-managed and appropriately organized supporting resources, the technical standards will fail to contribute significantly to the achievement of instructional goals.

COLLABORATION

It is imperative that schools work together at local, regional, and state levels in order to achieve a critical mass that will empower them to drive the technology market and procure equipment and services at dramatically reduced rates. Funding strategies and acquisition activities must be well-planned, organized, and coordinated. This unity of effort may have many partners, including local education agencies, Department of Public Instruction, universities, community colleges, private colleges, regional consortia, and city/county businesses and organizations. It is recommended that collaborative undertakings be considered for the following areas:

Purchasing	By joining efforts, educators can purchase hardware, software, supplies, maintenance, and support at greatly reduced rates.
Evaluation	Regional hardware test sites and software assessment centers would enable school personnel to become more competent technology decision makers.
Support	Sharing support personnel (technicians, resource personnel, and North Carolina Information Highway facilitators) may be a viable alternative for smaller schools and LEA's who otherwise could not afford such resources.
Maintenance	School districts should explore the possibility of forming partnerships to address maintenance and repair service needs.
Training	Consolidation of training efforts for professional, technical, and support personnel should be investigated.
License management	Centralized management of software licenses and upgrades would be beneficial for many schools.

The power of this coordination of efforts must not be underestimated. If this approach is undertaken seriously and energetically by the educators in North Carolina, eventually collaborative decision making as it relates to technology specifications, as well as other areas, will emerge.

CONNECTIVITY

School districts need to devise a comprehensive technology plan that can be implemented in phases. This plan should embrace the concept of connectivity, which is simply the linking of technology by wires and communication devices to facilitate rapid communication throughout the school and the district, as well as through the North Carolina Information Highway and beyond. Phase I of the plan should include the core infrastructure which will provide a basis for future procurement decisions, thus eliminating the need for additional retrofitting. School districts need to become adept at monitoring the technology industry to be sure they will be purchasing quality equipment whose life expectancy can be maximized. Among the issues that impact connectivity decisions are the following:

Security	There needs to be a hierarchy of rights for network users (students, teachers, administrators, etc.) to control access to the server and other resources.
Support	Technical and instructional support is a critical component of any plan and it is suggested that school districts investigate the possibility of sharing human resources.
Resource availability	Schools must plan for outside connections to access resources otherwise unavailable at the school, district, or regional level.
Wiring	All new buildings need to be wired for data, voice, and video transmissions. Guidelines for wiring standards have been established by the North Carolina Department of Public Instruction. Older facilities should include retrofit plans that are feasible and attainable.
Electronics	Plans should include the installation of wiring closets. Then as design phases are implemented, appropriate electronic components can be installed within the closets.
LAN	Local area networks link computers over a relatively small geographic area and should be part of an integrated model. Integrated models of networked schools are those designed to connect most or all parts of the school, so that technologies and databases are accessible and useful wherever they are needed.
WAN	Wide-area networks enable users to connect to sites outside the school, expanding student, teacher, and administrator outreach to external resources, databases, library resources, video retrieval, and other individuals. The plan for a wide-area network must include a router and a CSU/DSU (digital modem). This will make possible connection to the North Carolina Information Highway, facilitating communication among schools, LEAs, and the environment beyond.

HARDWARE/SOFTWARE CONFIGURATIONS

Determining Requirements

One of the most important concepts in technology planning is that curriculum and instruction decisions must be the driving force behind the selection and purchase of software and hardware solutions. The North Carolina Standard Course of Study provides a framework for the basic curriculum. It states that critical thinking skills and curriculum integration are important issues. In addition to this basic framework, each school must assume the responsibility for identifying the special needs in that particular learning environment. No two schools will develop the same technology plans for some of the following reasons:

- schools have different goals and priorities
- many types of resources, tools, and connections can effectively achieve the same goals
- choices schools make in developing their plans will vary significantly, depending upon what they already have to work with and their options for funding and assistance

When selecting learning and instructional management technology resources, educators need to consider the following:

- developmental needs of the K-12 instructional levels, elementary, middle, and high
- diverse learning styles and multiple intelligences
- exceptional abilities and aptitudes

There are many excellent software packages that target the important categories of educational technologies. These software programs can also be referenced by disciplines. Either way, certain conclusions can be drawn about hardware requirements by examining the software specifications. What is immediately evident is the wide range of RAM requirements for these programs (128K to 16MB). The trend has been toward increased memory capacity and processor speeds; therefore, workstations should be purchased according to current State minimum guidelines. This does not mean that every machine should have the same configuration. Some programs (multimedia, CAD, VoCATS) may require more memory or speed. Most elementary applications and multimedia CDs require sound which necessitates the use of headsets. The following pages contain information on configuration features based on criteria considerations current as of October, 1996.

Model Hardware/Software and Network Configurations

Model hardware/software and network configurations have been developed to assist in the purchase, training, support, planning, and operation of the four instructional technology initiatives described in the NCITP. These model configurations are:

- network-ready workstations
- network file servers
- portable computers
- printers

These model configurations emphasize the importance of connectivity capability. Schools need to move toward a consolidation of servers in a single network environment designed to connect most or all parts of the school building(s). Careful initial and ongoing planning is an integral part of creating a viable technology infrastructure with the flexibility and growth path necessary to respond to a school's increasing needs. This allows for a school's curricular and business needs, rather than hardware availability, to drive the selection of software.

The pages immediately following show the detailed configuration components and associated criteria and considerations for each model.

- Please note that information in the criteria column indicates considerations and concerns as of October 1, 1996. These criteria are dynamic and will change as necessary to reflect industry standards and innovations. When finalizing purchasing requests, one should use as complete and current a list of features and desired specifications as possible.

- Please note that an evaluation of a product should also include a performance-based assessment of that product's functionality in the anticipated business environment. Technology buying decisions should include a review of the benefits offered by the product, the cost of operating and supporting the product, the anticipated upgrade potential for the product, and the actual performance of the product in real-life operation.

- The current revision of this Guide can be referenced on the World Wide Web (WWW) homepage of the Department of Public Instruction and the WWW homepage of the Office of the State Controller's IRM Office. The Instructional Technology Division of the Department of Public Instruction and the IRM Office of the Office of the State Controller may be contacted directly for information and a current copy of the Guide.

- It is recommended that manufacturers be Novell Technical Support Alliance members.

- Please note that it may be appropriate to deviate from the suggested features list based upon specific business or technological reasons/needs. In such cases, there should be a documented justification or explanation for the deviation.

NETWORK-READY WORKSTATIONS

Guidelines

The purpose of this section is to provide a common basis for purchasing network-ready workstations. The technical criteria discussed below provide information by which to set specifications for quality units. In order to satisfy the needs of the end users, consideration should be given to the types of work performed now and the types of work anticipated within the next five years. The configurations chosen should attempt to extend the lifetime of the acquired workstations through the use of carefully tailored specifications. Local technical or business reasons/needs should provide the justification/explanation for the specifications chosen.

The following set of features and associated criteria is intended to help in the development of specifications for the acquisition of workstations and their components:

FEATURE	CRITERIA
Processor	A Pentium or Power PC workstation running at 75 MHz or greater can be used as a standalone or networked desktop computer. If the workstation is to be used with multi-media applications, a speed of 100 MHz or greater should be considered. Other equivalent processors can be evaluated and considered.
Cache	Performance will be enhanced through the use of 256 kb of cache. Other configuration solutions can be evaluated and considered for equivalent performance.
Fixed Disk	The capability to store an appropriate number of applications as well as required data and documents is improved through the use of a fixed disk of 400 MB or greater. If many multi-media applications will be used, a fixed disk of 500 MB or greater should be considered.
Fixed Disk Controller	Performance efficiency will be improved through the use of an enhanced IDE or SCSI-II controller.
RAM Size	The ability to run sophisticated applications and to maintain an array of open programs is enhanced by the use of 16 MB or more of RAM. If the workstation is to be used with multi-media applications, additional RAM should be considered.
Bus	Performance efficiency on Intel-based workstations will be enhanced by the use of a PCI bus.
Display	An adequate viewing area is provided by a 14 inch monitor, but a 15 inch monitor should be considered especially for graphical and multi-media applications. Larger viewing areas can be evaluated and considered for special uses and needs.
Resolution	Picture and text clarity can be improved by higher resolution and bit depth. Monitors capable of high resolution and bit depth should be able to adjust to lower resolutions and bit depth. An adequate resolution may be achieved with 640 x 480 pixels with 16,000 colors, but 800 x 600 pixels with 16,000 colors should be considered. If the workstation is to be used with graphical or multi-media applications, 1024 x 768 pixels may prove more satisfactory.
UART	A capability of 56 kbps will provide for communications at satisfactory speed. A 56 kbps UART should be able to adjust to lesser speeds as necessary.
CD Drive	If this is a desired option, a quad speed drive should provide satisfactory performance. Higher speed drives can be evaluated and considered.
Sound Adapter	If this is a desired option, 16 bit stereo will improve performance especially with multi-media applications. SoundBlaster compatibility may be required by some software. Sound in and out ports may be needed.
Miscellaneous	Plug and Play capability is an option to be evaluated and considered.

PORTABLE COMPUTERS

Guidelines

This section applies to all types of portable computers. When selecting a portable computer, consideration should be given as to who will be using it, where it will be used, and for what it will be used. In some cases, it will be advantageous to use a docking station to connect the portable computer to a network. In other cases, it will be more appropriate to use a LAN PCMCIA card to connect the portable computer to a network. Many of the PCMCIA cards can be shared by several users who do not need them at the same time. Some portable computers already have the required function(s) built in and, therefore, eliminate the need to purchase a PCMCIA card(s) for that function, *e.g.* a modem. The technical criteria discussed below provide information by which to set specifications for quality units. The configurations chosen should attempt to extend the lifetime of the acquired portable computers through the use of carefully tailored specifications. Local technical or business reasons/needs should provide the justification/explanation for the specifications chosen.

The following set of features and associated criteria is intended to help in the development of specifications for the acquisition of workstations and their components:

FEATURE	CRITERIA
Processor	A Pentium or Power PC computer running at 75 MHz or greater can be used in either a standalone or networked environment. If the computer is to be used with multi-media applications, a speed of 100 MHz or greater should be considered. Other equivalent processors can be evaluated and considered.
Fixed Disk	The capability to store an appropriate number of applications as well as required data and documents is improved through the use of a fixed disk of 500 MB or greater. If many multi-media applications will be used, a fixed disk of 800 MB or greater should be considered.
Fixed Disk Controller	Performance efficiency will be improved through the use of enhanced IDE. A SCSI-II controller should be evaluated and considered if the use of a CD ROM is anticipated.
RAM Size	The ability to run sophisticated applications and to maintain an array of open programs is enhanced by the use of 16 MB or more of RAM. If the workstation is to be used with multi-media applications, additional RAM should be considered.
PCMCIA	The computer must contain one Type III slot in order to accommodate a PCMCIA card. One Type III slot will serve as two Type I or II slots.
UART	A capability of 56 kbps will provide for communications at satisfactory speed. A 56 kbps UART should be able to adjust to lesser speeds as necessary.
External Connections	An external port which is SVGA or equivalent will allow a connection to a quality desktop display. An appropriate external connection port will be needed for a connection to a docking station or presentation display device.
Carry Case	A carry case should be available and may be included in the price of the base system.
Docking Station	If docking station capability is needed, it should be explicitly specified. The capability for "hot swapping," *i.e.* docking/unlocking while the portable computer is powered on, should be specified if desired. The ability to secure the portable computer while unattended through a key lockable docking station should be specified if desired.
Port Replicator	A port replicator should be available. If a Network Interface Card (PCMCIA) is required, then consider a docking station after costing out both solutions. Remember that the ability to secure the portable computer with a key lock may be an option available with the docking station solution.
Removable Fixed Disk	The capability to use removable fixed disks may provide a solution for multiple users who each need their own disk but who share the use of the same portable computer.
Extra Battery and Charger	If a portable computer is to be used for prolonged periods of time when it does not have access to a permanent power source, the acquisition of extra batteries and a charger should be considered.

LAN SERVERS

Guidelines

This section is intended to provide guidance to state agencies and institutions of North Carolina in purchasing computers to be used as LAN servers. The workgroup sizes indicated here are intended as a guide only. The most important factors in determining the level of server required are such factors as the critical nature of the functions (i.e. programs, data, etc.) supported by the server along with the performance requirements, system availability, data availability and system reliability. As the importance increases, then the need for a higher level server is indicated. One server with a tape drive may potentially backup other servers on the same LAN, assuming the tape drive has sufficient capacity. Servers should have the capability of performing a full-volume backup of all server disks (not including CD-ROM) to tape within a defined period of time which needs to be determined on a case by case basis. In some cases there will be short periods of time available with large amounts of data to backup; therefore, more than one tape backup device will be required. Management software is discussed with the Mid Range and High End Servers. An Uninterruptable Power Supply (UPS) should be required for all three levels of servers.

The following pages discuss features and associated criteria for different levels of LAN servers in order to help in the development of acquisition specifications.

LAN SERVERS - Entry Level

This level of server has relatively low fault tolerance and is appropriate for a small sized workgroup (approximately 25 users). This category is used for low end file servers or one of the following:

- When performance, system availability, fault tolerance and data availability are not critical
- Communications servers, *e.g.* modem, FAX, or World Wide Web (WWW)
- CD-ROM servers
- Other servers of relatively low-risk usage

The following set of features and associated criteria is intended to help in the development of specifications for the acquisition of entry level LAN servers and their components:

FEATURE	CRITERIA
Processor	A Pentium or Power PC workstation running at 75 MHz or greater can provide a good entry level server. A speed of 100 MHz or greater may provide better performance. Other equivalent processors can be evaluated and considered.
Fixed Disk	The capability to store an appropriate number of applications as well as required data and documents is improved through the use of a fixed disk capacity of 2 to 4 GB or more.
Fixed Disk Controller	Performance efficiency will be improved through the use of a SCSI-II controller.
RAM Size	The ability to respond satisfactorily to the requirements of a multi-user network environment is dependent on the use of 32 to 64 MB or more of RAM.
Expansion Bus	A configuration with at least 2 PCI, or equivalent, slots will allow additions to the current chassis. A better upgrade/growth path would be provided by having at least 3 free slots.
CPU to RAM Bus	Satisfactory throughput should be provided by a 32-bit bus.
Power Supply	A power supply of 225 watts or greater should be sufficient. All servers must have sufficient power for a fully populated box at maximum configuration.
Display	An adequate viewing area is provided by a 14 inch monitor, but a 15 inch monitor should be considered.
Resolution	Picture and text clarity can be improved by higher resolution and bit depth. Monitors capable of high resolution and bit depth should be able to adjust to lower resolutions and bit depth. An adequate resolution may be achieved with 640 x 480 pixels with 16,000 colors, but 800 x 600 pixels with 16,000 colors should be considered. A resolution of 1024 x 768 pixels may provide greater clarity if many graphical monitoring programs are viewed from the console itself.
CD Drive	An internal, SCSI-II, quad speed drive should provide satisfactory performance. Higher speed drives can be evaluated and considered.
Backup Tape Drive	Sufficient backup capability should be provided by a 4 mm DAT drive that can backup 8 GB with hardware compression.
Warranty	A 3 year on-site warranty with 72 hour problem resolution often provides sufficient recovery capability at a reasonable price. However, the need for a higher degree of response should be evaluated and considered if the business function of the network is critical.

ECC = error correction code
PCI = peripheral component interface
SCSI = small computer systems interface
DAT = digital audio tape
RAID = redundant array of independent disks
SMP = symmetric multi-processing

LAN SERVERS - Mid Range

This level of server has a moderate degree of fault tolerance and is appropriate for a medium sized workgroup (approximately 25 to 100 users) or servers which require more attention to the areas of performance, availability and reliability for either the server system and/or the data stored on the server. System management software to monitor server functions should be considered for the mid-range server. This category is recommended for mid-range servers or one of the following:

- Database Server, *e.g.* IMS, VoCATS, Media Automation
- Application Server, *e.g.* Microsoft Works, ILS

The following set of features and associated criteria is intended to help in the development of specifications for the acquisition of mid-range LAN servers and their components:

FEATURE	CRITERIA
Processor	A Pentium or Power PC workstation running at 75 MHz or greater with support for SMP can provide a good mid-range server. A speed of 100 MHz or greater may provide better performance. Other equivalent processors can be evaluated and considered.
Fixed Disk	The capability to store an appropriate number of applications as well as required data and documents is improved through the use of a fixed disk capacity of 2 to 6 GB or more configured as RAID 5.
Fixed Disk Controller	Performance efficiency will be improved through the use of a Fast/Wide 32-bit SCSI-II controller capable of RAID 5.
RAM Size	The ability to respond satisfactorily to the requirements of a multi-user network environment is dependent on the initial use of 32 to 64 MB or more of ECC memory and the expansion to 128 MB as required.
Expansion Bus	A configuration with at least 5 PCI, or equivalent, "bus master like" slots will allow additions to the current chassis and should provide a sufficient upgrade/growth path.
CPU to RAM Bus	Satisfactory throughput should be provided by a 64-bit or 128-bit bus at 100 mbps or more.
Power Supply	A power supply of 225 watts or greater should be sufficient. All servers must have sufficient power for a fully populated box at maximum configuration.
Display	An adequate viewing area is provided by a 14 inch monitor, but a 15 inch monitor should be considered.
Resolution	Picture and text clarity can be improved by higher resolution and bit depth. Monitors capable of high resolution and bit depth should be able to adjust to lower resolutions and bit depth. An adequate resolution may be achieved with 640 x 480 pixels with 16,000 colors, but 800 x 600 pixels with 16,000 colors should be considered. A resolution of 1024 x 768 pixels may provide greater clarity if many graphical monitoring programs are viewed from the console itself.
CD Drive	An internal, SCSI-II, quad speed drive should provide satisfactory performance. Higher speed drives can be evaluated and considered.
Backup Tape Drive	Sufficient backup capability should be provided by a 4 mm DAT drive that can backup 8 GB with hardware compression.
Warranty	A 3 year on-site warranty with 48 hour problem resolution often provides sufficient recovery capability at a reasonable price. However, the need for a higher degree of response should be evaluated and considered if the business function of the network is critical.

ECC = error correction code
PCI = peripheral component interface
SCSI = small computer systems interface
DAT = digital audio tape
RAID = redundant array of independent disks
SMP = symmetric multi-processing

LAN SERVERS - High End

This level of server has a high degree of fault tolerance and is appropriate for large sized workgroup file servers. This category would typically be used for servers of greater than 100 users or servers which require enhanced attention to the areas of performance, availability and reliability for either the server system and/or the data stored on the server. Generally, these servers provide the highest reliability. These servers normally have the highest initial purchase price. Server management software should also be considered for the high end server to monitor server functions. The server management software should also be able to monitor components under pre-failure warranty.

The following set of features and associated criteria is intended to help in the development of specifications for the acquisition of high end LAN servers and their components:

FEATURE	CRITERIA
Processor	A Pentium or Power PC workstation running at 75 MHz or greater with support for SMP can provide a good high end server. A speed of 100 MHz or greater may provide better performance. Other equivalent processors can be evaluated and considered.
Fixed Disk	The capability to store an appropriate number of applications as well as required data and documents is improved through the use of a fixed disk capacity of 4 to 10 GB or more configured as RAID 5 with "hot swappable" drives.
Fixed Disk Controller	Performance efficiency will be improved through the use of a Fast/Wide 32-bit SCSI-II controller with 2 or more channels and capable of RAID 5.
RAM Size	The ability to respond satisfactorily to the requirements of a multi-user network environment is dependent on the initial use of 64 to 128 MB or more of ECC memory and the expansion to 256 MB as required.
Expansion Bus	A configuration with at least 6 PCI, or equivalent, "bus master like" slots will allow additions to the current chassis and should provide a sufficient upgrade/growth path.
CPU to RAM Bus	Satisfactory throughput should be provided by a 64-bit or 128-bit bus at 100 mbps or more.
Power Supply	A power supply of 225 watts or greater should be sufficient. All servers must have sufficient power for a fully populated box at maximum configuration.
Display	An adequate viewing area is provided by a 14 inch monitor, but a 15 inch monitor should be considered.
Resolution	Picture and text clarity can be improved by higher resolution and bit depth. Monitors capable of high resolution and bit depth should be able to adjust to lower resolutions and bit depth. An adequate resolution may be achieved with 640 x 480 pixels with 16,000 colors, but 800 x 600 pixels with 16,000 colors should be considered. A resolution of 1024 x 768 pixels may provide greater clarity if many graphical monitoring programs are viewed from the console itself.
CD Drive	An internal, SCSI-II, quad speed drive should provide satisfactory performance. Higher speed drives can be evaluated and considered.
Backup Tape Drive	Sufficient backup capability should be provided by a 4 mm DAT drive that can backup 8 GB with hardware compression or by a Digital Linear Tape (DLT).
Warranty	A 3 year on-site warranty with 4 hour business hour response time and a 24 hour problem resolution often provides sufficient recovery capability at a reasonable price. However, the need for a higher degree of response should be evaluated and considered if the business function of the network is critical. A prefailure warranty to replace components after they exceed a threshold of errors but before they fail may be an option to evaluate and consider.

ECC = error correction code
PCI = peripheral component interface
SCSI = small computer systems interface
DAT = digital audio tape
RAID = redundant array of independent disks
SMP = symmetric multi-processing

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PRINTERS

This section applies to common types of printers. When selecting a printer, consideration should be given as to who will be using it, where it will be used, for what it will be used, and what volume of output is anticipated. ***Other printers may be desirable for specific applications or locations. The specifications for alternative printers should be decided on a case by case basis.***

NETWORK LASER PRINTERS

Guidelines

The following set of features and associated criteria is intended to help in the development of specifications for the acquisition of network laser printers:

FEATURE	CRITERIA
LAN	The capability to directly connect to the network, or to a "network print server box," is necessary for a true network printer. Such a printer does not require direct connection to a computer to provide all features and functions.
Speed	Network level performance can be achieved at a 5 ppm speed. However, the need for higher speeds based on business necessity or volume can be evaluated and considered. Speeds of 12 ppm or higher may be required for adequate response in a network environment with a high volume of print requests.
RAM	Network level performance can be achieved with 4 MB of RAM, but 8 MB may be needed with a Post Script printer. The need for additional RAM can be evaluated and considered based on the volume and types of printing done.
Resolution	A resolution of 300 DPI is usually sufficient, but 600 DPI may provide greater clarity for imaging and high quality work.
Languages	Good basic compatible languages include HP PCL and Post Script Level 2. If Post Script is not specified, it might be advisable to require the capability to be upgraded to support Post Script and to increase the RAM to 8 MB or more.
Rated Usage	The capacity to output 15,000 pages per month is usually adequate, but business needs and volume may require a higher usage rating.
Input Paper Capacity	A configuration with at least one 500 sheet paper drawer may reduce the monitoring and support of the printer.
Output Paper Capacity	A configuration with at least one 250 sheet paper capacity may reduce the monitoring and support of the printer.
Envelope Feeder	An automatic envelope feeder can provide ease of use and increased functionality to a network printer.

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STANDALONE LASER PRINTERS

Guidelines

The following set of features and associated criteria is intended to help in the development of specifications for the acquisition of standalone laser printers:

FEATURE	CRITERIA
Connection	A serial and/or Centronics parallel connection should provide an appropriate connection to standard workstations.
Speed	An adequate level performance can be achieved at a 4 ppm speed. However, the need for higher speeds based on business necessity or volume can be evaluated and considered. Speeds of 8 ppm or higher may be required for adequate response to an environment with a high volume of print requests.
RAM	Satisfactory performance can be achieved with 512 KB of RAM, but 8 MB may be needed with a Post Script printer. The need for additional RAM can be evaluated and considered based on the volume and types of printing done.
Resolution	A resolution of 300 DPI is usually sufficient, but 600 DPI may provide greater clarity for imaging and high quality work.
Software Compatibility	The ability to print from HP PCL, Quick Draw, and Post Script Level 2 should provide satisfactory performance. If Post Script is not specified, it might be advisable to require the capability to be upgraded to support Post Script and to increase the RAM to 8 MB or more.
Rated Usage	The capacity to output 10,000 pages per month is usually adequate, but business needs and volume may require a 15,000 pages per month or higher usage rating.
Input Paper Capacity	A configuration with at least one 100 sheet paper drawer may reduce the monitoring and support of the printer.
Output Paper Capacity	A configuration with at least one 100 sheet paper capacity may reduce the monitoring and support of the printer.
Envelope Feeder	An automatic envelope feeder can provide ease of use and increased functionality to a printer.

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STANDALONE INKJET PRINTERS

Guidelines

The following set of features and associated criteria is intended to help in the development of specifications for the acquisition of standalone inkjet printers:

FEATURE	CRITERIA
Connection	A serial and/or Centronics parallel connection should provide an appropriate connection to standard workstations.
Speed	An adequate level performance can be achieved at a 2.5 ppm speed for normal mode black and white and a 0.3 ppm speed for color.
RAM	Satisfactory performance can be achieved with 512 KB of RAM, but 8 MB may be needed with a Post Script printer. The need for additional RAM can be evaluated and considered based on the volume and types of printing done.
Resolution	A resolution of 300 DPI is usually sufficient, but 600 DPI may provide greater clarity for imaging and high quality work.
Software Compatibility	The ability to print from DOS, Windows, OS/2, System 7, HP PCL, Quick Draw, Quick Draw GX, and Post Script Level 2 should provide satisfactory performance.
Media Type	In order to provide satisfactory service, a printer should be capable of printing on normal weight paper plus light and/or heavy weight paper, transparencies, envelopes, etc. The range of media type required should be based on business needs and requirements.

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Comparison of Model Configurations

The different model configurations may be used for school-wide instruction and management; for media automation within the media center or distributed to the classrooms; or for special labs such as ILS, Chapter I, etc. However, any of these uses can be generalized into three conceptual approaches for implementing instructional technology into the schools:

- network-ready workstations
- networked lab—a large number of networked computers placed in a single room
- schoolwide network—similar to a networked lab, but the actual computers are placed in small groups in individual classrooms.

The table on the following page shows the advantages and disadvantages of each approach.

ADVANTAGES AND DISADVANTAGES OF THE CONFIGURATIONS

The general consensus around the issue of labs versus computers in the classrooms is that a mix including multiple organizational strategies, full-labs, mini-labs/clusters (even standalones) all connected by school/districtwide networks, is the ideal solution for most schools. The allows for curricular needs to drive the selection of hardware based upon software availability.

CONFIGURATION	ADVANTAGES	DISADVANTAGES
Network-Ready workstations used as standalone workstations	Available for use prior to having a network	Must purchase software for each workstation, unless use site license
		Must shuffle diskettes
		Lack of software management
		Difficult to share files, peripherals
		Need printer sharing devices or one printer per computer
Networked workstations in a lab setting	May share files/peripheral devices (printers)	Higher price tag (need server, cabling, retrofit)
	Software more economical	May need assistance in managing lab
	Whole class instruction	Need an extra room to house lab
	Software management centrally handled	One lab generally is not enough for large school
	Wider range of software available	
Schoolwide network with 4-5 workstations in every classroom plus other workstations in media center, resource rooms, labs, etc.	Different groups of students may use computers all day	Higher price tag (need server, extensive cabling, retrofit)
	Easy teacher access -- teaching/planning	Need more printers (one per classroom)
	File sharing possible among classrooms	Need network expertise (onsite assistance)
	Students become more active in learning process	
	Wider range of software available	
	Total connectivity throughout school opens door for greater communication (e-mail), future options	

As stated earlier, no two schools will adopt the same configurations. The reasons for this are 1) schools will have different goals and priorities to guide the decisions they make; 2) many types of resources, tools, and connections can effectively achieve the same goals; and 3) the choices schools make in developing their plans will vary significantly, depending upon what they already have to work with and their options for funding and assistance. It is important for schools to be given the opportunity to implement the configurations that best meet their needs.

Other Considerations

The preceding tables depict the minimum hardware recommendations that may be used as benchmark configurations in a basic technology plan. These guidelines may be used for purchasing new resources. They also establish the standards by which in-place school technology programs may be assessed. This, in turn, determines the additional resources necessary to ensure the desired result in every school.

However, there are other areas which must be addressed when planning for technology. These considerations fall within the realm of facility retrofit. It is important to determine what is required to bring a given school facility up to signal distribution (data, voice, and video) and electrical supply standards necessary to install the schoolwide basic technology program. North Carolina has established a set of standards for networking, cabling , and telecommunication which schools should use when developing their plans. The most current versions of the following North Carolina documents may be referenced for standards:

- Requirements and Procedures for Installing Local Area Networks
- A Primer on Cabling Design and Implementation: Considerations for Decision-Makers
- Guidelines to Provide Uniform Wiring Service for Telecommunications in North Carolina Public Schools

Heating, ventilation, air conditioning, environmental issues (noise, radiation, lighting), furniture, and space requirements also need to be addressed.

Supporting Documents

The Department of Public Instruction, the Information Resource Management Council (IRMC), and the North Carolina Information Highway project have developed a series of technical standards, recommendations, statements of direction, and other aids to assist schools and districts in implementing a wide range of instructional technology. The table on the following pages references all of the documents available to support the technological infrastructure needed for the four instructional initiatives.

North Carolina Technical Standards and Guidelines

Area of Consideration	Preliminary Standard	Recommendation or Statement of Direction	Implementation Aids and Supporting References
1. Internal LAN of only Motorola/PowerPC machines on a single server	Macintosh Operating system (System 7), AppleTalk/Ethernet networking, AppleShare file and print services	No Current Standard but approved for implementation	The guide to the NCITP entitled Technological Recommendations and Standards
2. Internal LAN of only Intel machines on a single server	DOS/WINDOWS operating system, Novell networking, file, and print services	IRMC approved standards	Page 4 of Technology Standards and Supporting Products for Local Area Networks The guide to the NCITP entitled Technological Recommendations and Standards
3. Internal LAN of mixed Motorola/PowerPC and Intel machines on a single server	Workstation operating systems as specified above. Networking protocols same as above for native environments; however NetWare for Macintosh supports file and print services on common server with Novell "intel" file and print services to enable the sharing of files and print services between both environments.	IRMC approved standards	Page 4 of Technology Standards and supporting Products for Locals Area Networks The guide to the NCITP entitled Technological Recommendations and Standards
4. Inter-network Transport	TCP/IP	IRMC approved standard is TCP/IP	Page 5 of Technology Standards and Supporting Products for Local Area Networks
5. LAN Topology for the School	Ethernet wired to state telecommunications standards	Ethernet is recommended for all new installations. Token Ring is acceptable if it already exists in the school. Multiple bridged/routed LANs of Apple and Intel servers are acceptable.	Page 4 of Technology Standards and Supporting Products for Local Area Networks STS-1000 Telecommunications Wiring Guidelines

North Carolina Technical Standards and Guidelines

Area of Consideration	Preliminary Standard	Recommendation or Statement of Direction	Implementation Aids and Supporting References
6. Electronic Mail (e-mail)	SMTP/MIME/POP3 products	IRMC Standard	IRMC Approved, January 4, 1994 and March 1, 1994; Electronic Messaging/Mail
7. LAN Physical Infrastructure	State Wiring Standards: UTP Level 5 (EIA/TIA 568A) and/or Fiber Optic Multimode with ST connectors. Intelligent Hubs: SNMP compliant hubs. Bay Networks hubs with Optivity software are recommended.	IRMC Standard IRMC Standard	DPI Guidelines to Provide Uniform Wiring Service for Telecommunications in N.C. Public Schools DPI Primer on Cabling Design and Implementation
8. Video	State Published Specifications		DPI Guidelines to Provide Uniform Wiring Service for Telecommunications in N.C. Public Schools DPI Primer on Cabling Design and Implementation NCIH Documents
9. Telephony and Voice Messaging			IRMC Approved September 7, 1993, Voice Processing Standards

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